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ABSTRACT

Described is a pre-1970 history of the participation of women in science and engineering, including numbers for women enrolling in college in these two fields. A discussion of opportunities for employment and advancement, and salary differentials for men and women prior to 1970, is included. Opportunities for publication, reemployment, and assignment to prestigious committees are discussed as examples of practices discriminatory to women. Enrollment numbers for 1974 are cited for science and engineering and of undergraduate and graduate degrees with a breakdown of women's participation. Surveys of new graduates hired by industry are summarized. Included is a discussion of demand and supply in the present job market. Positive predictions, particularly favorable for women, are made regarding job opportunities for future graduates in both areas. (CS)

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RECENT CHANGES IN OPPORTUNITIES FOR WOMEN IN SCIENCE AND ENGINEERING

by

Betty M. Vetter

In terms of job opportunities, women may have chosen an unfortunate time to begin the current wave of their drive for equal rights and equal opportunities. The second half of the fifties and the first half of the sixties constituted a period of generally rising demand and very little oversupply in the sciences, but the participation of women in the scientific enterprise during this period was still declining or remaining static in almost every area of science. It was not until late in the sixties that employment problems began to emerge, particularly for some of the physical scientists and engineers as the recession of 1970 began to deepen, and as cutbacks in federal programs such as space exploration brought about sharp reductions in the work force. This period coincided with the first real efforts at consciousness raising among women since the fight for suffrage. For the first time in several decades, substantial numbers of women again began to consider participation in all segments of the professional work force. There were few role models, although there were some in all fields of science.

The social and life sciences included significant numbers of women, but the proportion of women in the physical sciences had dropped below five percent at the doctorate level, and the proportion in engineering at any degree level did not reach the one percent level before 1970.

You have seen the figures Dr. Kistiakowsky has discussed, and can recognize how alone these women scientists and engineers must have felt in the fifth and early sixth decade of this century. They were employed, although at salaries significantly below those of their comparable male colleagues. Their opportunities for advancement were universally less than those of men, despite the fact that the selective filters of conditioning and custom had strained out all but the exceptionally superior and dedicated women.

Increases in the participation of women have been more rapid than have positive changes in opportunity during the past five years. In some fields, the gain in participation appears enormous. In engineering, for example, where women were only 1.6% of the freshman class in the fall of 1969, they make up between ten and eleven percent in this school year- a 575% increase in only six years. This bulge has not yet reached the other end of the educational pipeline, of course. Women made up less than two percent of the baccalaureate graduates in 1974, about 2.5% of the masters and only one percent of the doctorates. There were only 183 women among the more than 21,000 doctorate awardees in engineering from 1969 through 1974.

Because women engineers are still so rare, the heightened awareness of employers to the sexist discrimination of the past has brought real opportunity to new women engineering graduates in the past few years. Indeed, there is little or no involuntary unemployment among new women graduates in engineering at any level, although a substantial proportion of the 1975 graduating class of men was still without offers or plans at the time of graduation. We have used engineering as an example, both because of the tremendous percentage increase in participation of women, and because this field, together with physics where women earned only four percent of the 1974 doctorates, stands at the low end of the science/engineering spectrum in proportion of women graduates. Because the employment market for physicists has been worse than for new engineers, the opportunities for women graduates in engineering have exceeded those in physics.

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Despite the favorable job picture for women engineering graduates, the opportunity gap between the sexes continues to exist. Among all physical science doctorates in 1974, about 69% of the total but only 53% of the women had found employment or post doctoral positions at the time the degree was received.

At the other end of the spectrum, in the life, behavioral and social sciences, where women make up between twenty and thirty percent of new 1974 doctorates, the employment picture is about as dismal as in the physical sciences for women as compared to men. Whereas 72% of all life and bioscience graduates had definite plans for employment or postdoctoral study at the time the degree was awarded, only 65% of the women had found such opportunities. In the social and behavioral sciences, 75% of the total but only 65% of the women had definite plans for postoctoral study or for employment.

We can see that, while the proportion of women enrolled and graduating in these fields is increasing, their opportunities for employment and advancement in the jobs in industry, government or academe that lead to responsible participation in the scientific workforce continue to be limited.

A falling employment market for new graduates and specifically for new Ph.D's has created problems for men as well as for women, but the relative position of new women doctorates has deteriorated over the past several years. The unemployment rates for women in science (and indeed for women in all fields of specialization) continue to be two to five times higher than for men in the same field with comparable training and experience.

Women scientists not only have more difficulty finding employment than do men with comparable education and experience; they also find it more difficult to advance. Their salaries continue to be lower than those of comparable men in every employment setting, at every degree level and at every level of experience. Salaries for women Ph.D's in science and engineering who were under 30 years of age in 1973 were $1,600 below salaries of men in the same age bracket, according to a National Research Council study published in 1974. At age 40, women's salaries lagged $4,300 behind men's and by age 50, Ph.D. women in science received $6,200 per year less than men.

While the salary differential is highest in the older age groups, it persists even among new graduates. For example, offers by business and industry to new women baccalaureate graduates in chemistry and in mathematics in the 1974-75 recruiting year averaged $216 per year below offers to men; in the biological sciences $768 less; and in other physical and earth sciences, $1,332 less. Only in engineering did salary offers to women slightly exceed those made to men.

Cultural tradition, sex role expectations and discriminatory practices have played and still play a large role in the training and employment opportunities of women at the doctoral and lower levels of academic achievement. Particularly in the sciences, reemployment opportunities for women who wish to leave the work force for a time to have and raise a family are hazardous. Part time employment in science is not readily available under most circumstances. It is not surprising, then, despite increases in the proportion of women entering science and engineering fields, that the numbers remain far below their proportion in the population or even in the student population.

Among those women who, against considerable odds, have chosen science careers and are now in the work force with exceptionally fine credentials, some have found that barriers to progress in their professional careers are dropping. Others still struggle, not so much with the blatent sexism which they faced a few short years ago, but with the subtle barriers put in their way.

Women scientists who are unable to participate socially with their male colleagues are not included in some of the exciting plans or discussions that may lead to new discovery and ultimate publication. Women who are not offered the opportunity to serve on prestigious committees of scientists discussing science (but are asked, instead, to serve on committees devoted to affirmative action, the status of women, or improving the lunch room) are unlikely to share in development of those scientific projects which will result in publication -that inescapable rung on the ladder of advancement.

While the opportunities for women in science are better than for women in most other fields, opportunities are not much better than they were five years ago, before "affirmative action" was mandated by Executive Order, and, as we shall see, not as good as they were five years ago for reasons having nothing to do with sex. There are some gains in the proportion of women among new graduates in science, and even larger gains in the proportion of women enrolled in graduate programs in these fields. A few women have been promoted into positions of greater responsibility, both in industry and in academic institutions, but science remains a man's world, dominated by a male fellowship in which only a few women have an opportunity to participate fully.

Sex barriers would drop much faster in a rising employment market than in a stable or falling market. The really important factor in opportunities for women is the marketplace for scientists and engineers.

Let's look at the present job market in science and engineering, examining the supply side first.

At a time when more and more students are entering the nation's institutions of higher education, including its graduate schools, enrollments in the physical sciences are falling both as a percentage of all students enrolled and in actual numbers. As a percentage of all bachelor's degrees granted, the combined total of those in physical science and engineering fell from 20% in 1950 to 14% in 1960 and to 8% in 1970. Current projections indicate a further drop to below 5% by 1982. At the master's level, engineering is about where it was 20 years ago, although the percentage of science and engineering degrees together has dropped from 14.6% to 9.7% in the past ten years. That drop is expected to continue through 1983.

Despite the falling percentages in the physical and engineering sciences, because of the increasing size of the college population the actual number of degrees granted in these fields generally held steady or increased through the sixties at all degree levels while those in the biological sciences rose rapidly. However, while the college population still continues to expand as it will for another six years, both the percentage and the number of actual enrollments fell over the past four years in the physical sciences and engineering while rising rapidly in the biosciences.

In engineering where we can measure intended majors even at the freshman year, the drop from the fall of 1970 to the fall of 1971 was a whopping 18%, followed

by a further 11% drop in the fall of 1972. In fall 1973, the drop was only three tenths of a percent and in the fall of 1974 enrollments started up again. This year's class is up 20% over last year, with a tremendous increase in the proportion of women, as we have noted. When freshman enrollment is plotted against bachelors degrees four and a half years later, we can see that the supply of new engineering graduates may drop to about 30,000 in 1976 while the Labor Department continues to project demand for 53,000 new engineering graduates per year through the mid 1980's. By 1980, the graduating class will be up again, and will include significant numbers of women.

In physics, the enrollment drop is similar to that in engineering and the number of bachelor's degrees granted began to fall in 1969-70. The drop continues through 1974. Women made up 8% and 9% of the lower degree graduates, and four percent of the doctorates in physics in 1974.

In chemistry, the number of bachelor degrees dropped beginning in 1970, and doctorates in 1971. The number of new Ph.D's is expected to fall below 1500 by 1976. Women chemists earned 20% and 21% of the bachelor's and master's degrees in 1974, and ten percent of the doctorates.

In the biological sciences, degrees are rising rapidly at all levels, and women are almost a third of the bachelors and masters graduates; more than a fourth of the doctorates in 1974. You will not be surprised to learn that the life sciences are a field where supply is expected to exceed demand at every level by the mid-eighties. Enrollments in the health fields also are rising rapidly.

Medical school enrollments are up, with the proportion of women in the new class having risen to almost 24% in the fall of 1975. Among 1974 graduates, 11% were women.

In the geological sciences, where demand is increasing rapidly as a result of the energy problems of the country, you will note that the degrees are leveling off. The only reason they are not falling is the increased enrollment of women who made up almost 19% of the undergraduate enrollment in 1974, 14% of masters enrollment and 10% of enrollment for doctoral degrees. These represent increases of 34% from the previous year for the undergraduates and 21% for women doctoral students.

The pattern looks fairly clear; students are enrolling in fields that are already overcrowded while enrollment has been dropping in fields such as engineering, chemistry and geology where shortages are forecast. The proportion of women is rising in all these fields, but is still far below their proportion among all students.

A quick look at graduate enrollment over a three year period shows the picture very clearly. Enrollment is rising, and fairly rapidly, in fields where surpluses already exist and more are predicted. Enrollments are falling in the physical sciences and engineering where generally jobs are expected to exceed supply. However, the proportion of women among all graduate students rose to 42% in 1974 and was 43% among first year graduate students. We do not yet have field enrollment breakouts by sex for that year.

How about current demand for scientists and engineers?

While we are all aware of changing patterns of hiring in academic institutions, we might look at what has happened in industry in the hiring of new graduates

during the seventies. Industry is the only sector where substantial new jobs can be expected over the next decade or so, since education will no longer be a growing enterprise, and government employment is not expected to expand at anything resembling the growth rate of the past two decades.

Industry hires of new graduates were substantial in 1969-70, but dropped for all categories of graduates in 1970-71 as that recession took hold. The largest drop, proportionally, occurred in the hiring of non-technical and non-business graduates, which fell 47%. The next year, graduates in engineering and business were hired in numbers exceeding the 1969-70 level, and the science/math group passed that level a year later. Increases continued in every group through 1973-74 and dropped during this current recruiting season for all types of graduates. However, note that in every case except the "other nontechnical" group, hiring was still higher than in 1969-70. Persons with non-technical degrees are almost 70% of all graduates, but got only 17.5% of the jobs in business and industry over the first half of the decade.

The latest survey by Frank Endicott of Northwestern University indicates that employers plan a 45% increase in hiring of women from 1976 classes but the state of the economy will be a major determinant of whether these plans materialize.

We have dealt only with the supply of new graduates, not taking into account the working professionals already in these fields who are potentially capable of a good deal of transfer from one field to another. The picture we have shown is thus a very simplistic one. However, people do move all the time out of the fields in which they were trained and into others. Sometimes this is because changing interests or better opportunities bring about a move. In other cases, people are pushed out of the field of their choice by lack of opportunity and enter other specialties where opportunities do exist.

It is important, however, that we note that scientists and engineers may switch across fields within the whole technological enterprise, and may switch out of science and engineering altogether; but that nonscientists and engineers are not generally able to enter the manpower pool of scientists and engineers. We should also be aware that when unemployment exists, women are more likely to be unemployed than men. For example, the American Chemical Society reports that unemployment among its member chemists was 1.5% for men and 2.7% for women in March, 1975; compared to figures a year earlier of 1.2% for men and 3.5% for women. Thus, the women as a group are a little better off than they were a year ago, while the men are experiencing slightly more unemployment. The women, however, are still holding the long end of the unemployment stick. This is true in every science field at all degree levels, except for new baccalaureate engineers.

Another current measure of short range demand for both experienced and inexperienced professionals is the Engineer/Scientist Demand Index maintained by the New York advertising firm of Deutsch, Shea and Evans. This index is based on classified ads, display ads, and journal ads for science and engineering jobs. The Index has fluctuated widely over the past fourteen years, peaking in 1966 and reaching its lowest point in the 1970-71 recession. It rose substantially in the first half of 1974, dropped in the second half, and stayed low and fairly steady in 1975.

While this index includes both jobs for new and for experienced scientists and engineers, it is principally an index of demand for experienced people. In engineering, particularly, there are two quite distinct markets for engineers, and they

operate differently. This is why we can have a shortage of new engineering graduates at the same time that statistics show a rising unemployment rate among experienced engineers.

New engineers are recruited through their colleges and universities at the time of completion of their degrees, while the experienced engineer marketplace includes not only engineers with degrees in engineering but also engineers who have reached that title through experience only. Our engineering workforce, as measured by the Census Bureau and the Bureau of Labor Statistics, includes a substantial proportion of persons who have no college degree at all, as well as a number whose degrees are in fields other than engineering.

Despite these findings of lowered demand, unemployment is low among scientists and engineers relative to other groups with similar amounts of education, although it is higher than it was six months or a year ago.

How about the future? Dr. Wallace will examine this area, but we might note that the opportunities in science and engineering depend in large measure on what the federal government does about spending on those activities where large numbers of technologically trained persons are used.

Congressional decisions for funding energy programs will be of the greatest importance in determining the demand for scientists and engineers; along with decisions regarding environmental activities, food technologies, and a host of other national enterprises.

One of the major reasons why nobody is able to make good forecasts of supply and demand over a period of ten years or so is the inability to forecast what these governmental decisions will be. We also cannot predict the unexpected discovery or event that will change the forecast, although we can be quite sure that it will occur. Nonetheless, forecasts are made, and Dr. Wallace will examine some of them with you.

One important thing to remember in examining projections is the difference between need and demand. It is not difficult to carry out a study of manpower needs for any given objective such as energy independence, environmental cleanup, or better national health, provided we can state the objective and set the time by which we wish to have accomplished it. One other factor, however, must be added, if we are to translate manpower needs into manpower demand. That factor is money. Only when funding is added can people be hired, no matter how many may be needed.

There are now, and will continue to be for the foreseeable future some imbalances in supply and demand among scientists and engineers. At the moment, the engineering profession below the doctorate level shows the greatest potential imbalance on the low side of supply. The life sciences appear to be slated for the largest oversupply, both at the doctorate and lower degree levels. The physical sciences are somewhere in between, with chemistry offering more promise of opportunity than physics, geology offering more than chemistry, barring unforeseen changes in either supply or demand trends.

Increasingly, job opportunities will have to be sought in industry and not in academic settings, where there is now universal agreement that relatively few job opportunities will be available for the projected supply of new doctorates, at least through the middle eighties.

The alert scientist or engineer will keep an eye on the changing marketplace, be aware when funds are drying up for one kind of activity and enlarging

for others, and be prepared, if necessary, to consider some cross-field mobility.

Despite the gloomy prognostications rampant in current government projections of supply and utilization, the picture for scientists and engineers generally is pretty good. If that doesn't seem true to you, just examine the position of the new graduates, and even the experienced ones in the humanities and in some segments of the social sciences, so that your perspective enlarges a little. We do not anticipate "full employment" at the appropriate level for all the scientists and engineers in the country, either tomorrow or a few years from now. I don't believe there will be much unemployment, either.

The tragedy, if indeed there is any, will be for those individuals who have cut down on their opportunities for field switching by staying in too narrow a channel, or by not having kept up with developments outside a narrow specialty; and for those whose vision of successful employment is so limited that what might otherwise be seen as interesting options are viewed only as representing failure. Barring that unforeseen development which is bound to occur, I do not see any forthcoming crisis in science and engineering employment, either because of shortages or surpluses. If viewed too narrowly, however, some individuals in this technological pool may face a crisis of unmet expectations.

Women as well as men will have to make some of their own opportunities. Women scientists, long underrepresented, underpromoted and underpaid in their fields relative to men, have not achieved parity of opportunity despite the forces of affirmative action. Gains in the participation of women in the U.S. scientific enterprise are relatively small, and the obstacles still standing in the path of those who wish to enter and participate fully in that enterprise always have been and still are enormous.

On the other hand, affirmative action efforts will, in some instances, favor women. Women will increasingly demand and are entitled to their share of the rewarding opportunities in the sciences and in the management of the technological enterprise. Ultimately, they will get it. This change will come faster if employment generally is rising, and specifically if demand for scientists and engineers increases more rapidly than now appears to be the case.